Technical Report 751

Lessons Learned in Research on Command Group Training

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Research Institute for the Behavioral and Social Sciences

July 1987

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A186 996

REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: ARI Technical Report 751	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): LESSONS LEARNED IN RESEARCH ON COMMAND GROUP TRAINING	5. TYPE OF REPORT & PERIOD COVERED: --
6. PERFORMING ORG. REPORT NUMBER: --	
7. AUTHOR(s): Ira T. Kaplan	8. CONTRACT OR GRANT NUMBER(s): --
9. PERFORMING ORGANIZATION NAME AND ADDRESS: U.S. Army Research Institute for the Behavioral and Social Sciences, 5001 Eisenhower Avenue Alexandria, Virginia 22333-5600	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 2Q263744A795
11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. Army Research Institute for the Behavioral and Social Sciences, 5001 Eisenhower Avenue Alexandria, Virginia 22333-5600	12. REPORT DATE: July 1987
	13. NUMBER OF PAGES: 41
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): --	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: --

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

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18. SUPPLEMENTARY NOTES

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Battle simulations,
Command group training,
Communication,
Performance measurement,
Training effectiveness,
Training feedback,
Training objectives.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report summarizes lessons learned in research on command group training conducted by the Army Research Institute's Fort Leavenworth Field Unit from 1976 to 1984. The lessons learned are grouped under the headings of training objectives, performance measurement, training effectiveness, and feedback. Major results include the development of more objective measures of command group performance, the finding that battle simulations satisfy certain training objectives better than others, and the beneficial effects of providing

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ARI Technical Report 751

20. Abstract (Continued)

additional feedback during training. The lessons learned in this research were used in the development and operation of battalion command group training systems. They can also be used to facilitate the development of future systems to train command groups at corps and division levels. Keywords:

FLD 19

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Lessons Learned in Research on Command Group Training

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July 1987

Army Project Number
2Q263744A795

Training and Simulation

FOREWORD

The Fort Leavenworth Field Unit of the U.S. Army Research Institute conducts a systems and training research program in support of the Combined Arms Center. From 1976 through 1984 the Field Unit worked on determining training objectives, developing performance measures, evaluating training system effectiveness, and analyzing the effects of feedback on command group performance. This research was performed in cooperation with the military developers and operators of automated battle simulation systems used to train battalion command groups in the command and control of combined arms operations, especially CATTS, the Combined Arms Tactical Training Simulator, CAMMS, the Computer Assisted Map Maneuver System, and ARTBASS, the Army Training Battle Simulation System.

The reporting of these lessons learned was conducted as part of the ARI Research Task 1.3.3., Improved Methods for Command Group Training. The work was performed under agreement with the Command and General Staff College, Memorandum of Understanding entitled "Research and Evaluation Program for Present and Future Command and Control Requirements and Operations," dated 31 May 1983. The results of this research were briefed to the Director, Training Support Directorate of the Combined Arms Training Activity on 1 August 1985. The lessons learned in this research are being applied to the development of command group training systems at the corps and division levels.

EDGAR M. JOHNSON
Technical Director

LESSONS LEARNED IN RESEARCH ON COMMAND GROUP TRAINING

EXECUTIVE SUMMARY

Objective:

The purpose of this report is to summarize lessons learned during several years of research on the development of automated battle simulations for training battalion command groups.

Procedures:

Data were collected at over 100 command group training exercises. Measures of command group performance and training system effectiveness were obtained by means of surveys, interviews, multiple-choice questionnaires, task-performance ratings, responses to critical events (probes), and simulation outcome measures.

Findings:

The lessons learned in this research were grouped under four headings: training objectives, performance measures, training effectiveness, and feedback.

The objectives of a training system should be determined empirically, i.e., by observing and interviewing the participants at training exercises. A battle simulation does not necessarily train, or need to train, all the tasks that a command group performs in combat. A training system's objectives may be defined as the subset of tasks that are both strongly related to overall effectiveness and commonly deficient. Training objectives, so defined, vary with the unit's mission. They also depend on the command group members' experience and goals. The system's and the command group's common objectives should determine the content of the training exercise and the feedback given to the members.

A variety of measures should be used to assess different aspects of command group performance. Performance ratings are easy to obtain from exercise controllers and from the players themselves, once suitable rating scales have been developed. But their usefulness is limited by the rater's ability to discriminate among different tasks, as well as by individual differences among raters. More objective measures have been developed to overcome these limitations, including measures of information flow, responses to critical events (probes), and simulation outcome measures. These measures are useful for providing players with feedback to help them improve their performance and for providing the trainers with feedback to help improve the training system. Further research should be done to develop objective measures of planning and decision-making behavior, to develop automated measures of

performance, and to make use of advances in audio- and video-recording technology.

Automated battle simulations create a realistic experience, but they train some command group members more than others. Commanders, operations, fire support, and intelligence are trained better than logistics and administration. It would be desirable to develop modular systems that train individual staff sections. In addition to providing each staff element with optimally focused training, such part-staff trainers could be used to provide supplemental training to less experienced staff members. At corps and division levels, part-staff trainers would be an economical alternative to large-scale exercises for the entire staff.

Merely participating in an exercise does not necessarily improve command group performance. To maximize the training benefit of an exercise, the group members should be given extensive feedback about their performance. In particular, they should be given feedback relevant to their training objectives. The optimum content, duration, and format of feedback remains to be determined, but it should incorporate the playback capability of automated simulations, audio-video inputs, and objective performance measures, as they continue to be developed.

Utilization of Findings:

The lessons learned in this research were used in the development and operation of battalion command group training systems. They can also be used to facilitate the development of future systems to train command groups at corps and division levels.

LESSONS LEARNED IN RESRARCH ON COMMAND GROUP TRAINING

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LESSONS LEARNED IN RESEARCH ON COMMAND GROUP TRAINING

INTRODUCTION

This paper summarizes the lessons learned in research on the development of command group training systems, conducted by the Army Research Institute at Fort Leavenworth from 1976 to 1984. The major systems studied during this time were CATTS, the Combined Arms Tactical Training Simulator; CAMMS, the Computer Assisted Map Maneuver System; and ARTBASS, the Army Training Battle Simulation System. Since the methods and results summarized in this paper came from research on training systems, they can readily be grouped into categories derived from a model of training system development. In addition to providing a framework for organizing the results, the model also indicates where the methods can be applied in the development of future command group training systems. Therefore the lessons learned will be presented in the context of a model of training system development, which is diagrammed in Figure 1.

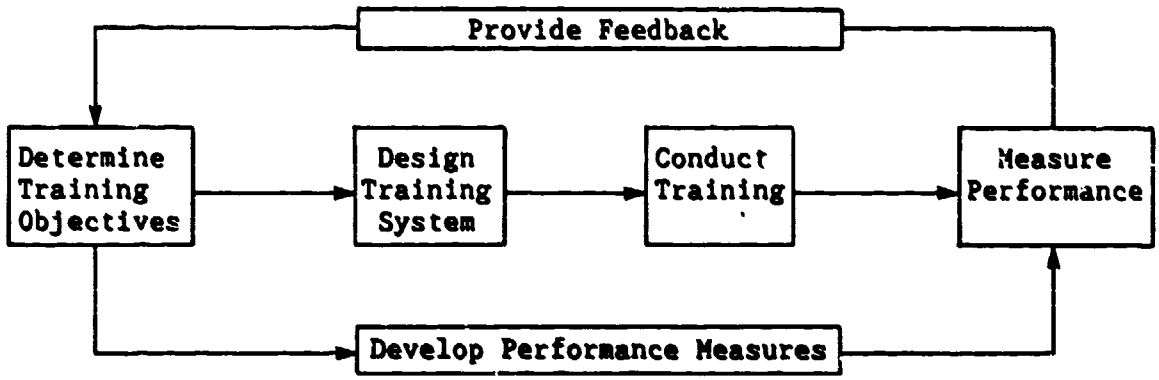

Figure 1. A model of training system development

The first step in the model is to determine the objectives of the training system, i.e., the tasks that need to be trained. These objectives support the design of the training system and the development of performance measures, which are the next two steps in the model. The measures in turn are used to assess performance before, during, and after training. Then the results are used to provide feedback to help the trainees improve their performance, to help the designers increase the effectiveness of the training system, and to refine the original training objectives. It is important to note that this model for training system development applies also to training system utilization. Given an existing training system, for example, it is typically advisable to "design" a system configuration (to include type of scenario, length of the exercise, number of trainees, etc.), appropriate to the training objective of a given group of trainees. The lessons learned in the ARI research program apply to both training system development and utilization, and the model in Figure 1 should be integrated in this broader context. In the framework of this model, principles of command group training will be

presented under the headings of lessons about (1) training objectives, (2) performance measurement, (3) training effectiveness, and (4) feedback.

TRAINING OBJECTIVES

There are several reasons why it is important to specify the objectives of a training system: (1) to define the purpose of the system, (2) to develop performance measures, (3) to conduct exercises that meet the objectives of the individuals who are trained, (4) to provide feedback that addresses those objectives, (5) to evaluate the system's effectiveness, and (6) to provide the system developers with feedback about how well the system satisfies its objectives. It is essential that the system developers, the controllers who conduct the exercises, and the command groups that participate in them all share a common understanding of the training objectives.

The general purpose of a command group training system is to train the commander and his staff in the control and coordination of combined arms operations. But this statement is not specific enough to support the design of a training system or the development of performance measures. A much more detailed description of potential training objectives is given in the Army Training and Evaluation Program. ARTEP 71-2 contains a list of training objectives (tasks, conditions, and standards) that a battalion command group must achieve to perform successfully on the battlefield. The 1977 edition of ARTEP 71-2 was used in an investigation conducted to define the training objectives of CATTS (Barber & Kaplan, 1979). Taking the command group module of ARTEP 71-2 as a starting point, this investigation sought to discover which tasks were exercised in CATTS, which tasks were most important, in the sense that they were strongly related to overall performance, and which tasks most needed to be trained, because they received relatively low performance ratings. The CATTS controllers used the ARTEP tasks and standards to rate the performance of 27 battalion command groups with the results described under Lessons 1, 2, 3, and 4.

LESSON 1 - Simulations did not train all the tasks the command group needed to perform. One of the first lessons learned in the attempt to measure task performance was that CATTS did not exercise all the ARTEP tasks. CATTS did train most of the tasks that a battalion commander and his staff would perform in their command post. Eighteen percent of the tasks (11 of 61 tasks), however, were not exercised in CATTS. Some tasks were not exercised because they could only be performed in the field, e.g., camouflage. Other tasks were not modeled in the simulation, e.g., react to chemical, biological, or nuclear attack.

LESSON 2 - Certain tasks were particularly important for command group effectiveness. Fifty tasks were too many to observe, evaluate, and provide feedback about. Therefore, it was necessary to identify a smaller set of tasks as training objectives. One criterion used to identify training objectives was that of being significantly correlated with ratings of overall effectiveness. About half the tasks exercised in CATTS were found to be important by that criterion. Ratings for 23 of the 50 tasks exercised were significantly correlated ($p < .01$) with overall effectiveness ratings, i.e., these tasks were strongly associated with overall effectiveness. Most of these tasks were performed by the battalion commander, the S2, and the S3.

LESSON 3 - Certain tasks received low performance ratings. A second criterion used to identify training objectives was that they were frequently deficient. Nineteen tasks were identified as deficient because they received mean ratings which were more than one standard deviation below the mean of all 50 tasks that were exercised in CATTS. Figure 2 illustrates the relationships among several subsets of tasks: those which were exercised, important, and deficient. Of particular interest is the subset of 14 tasks which were both important and deficient.

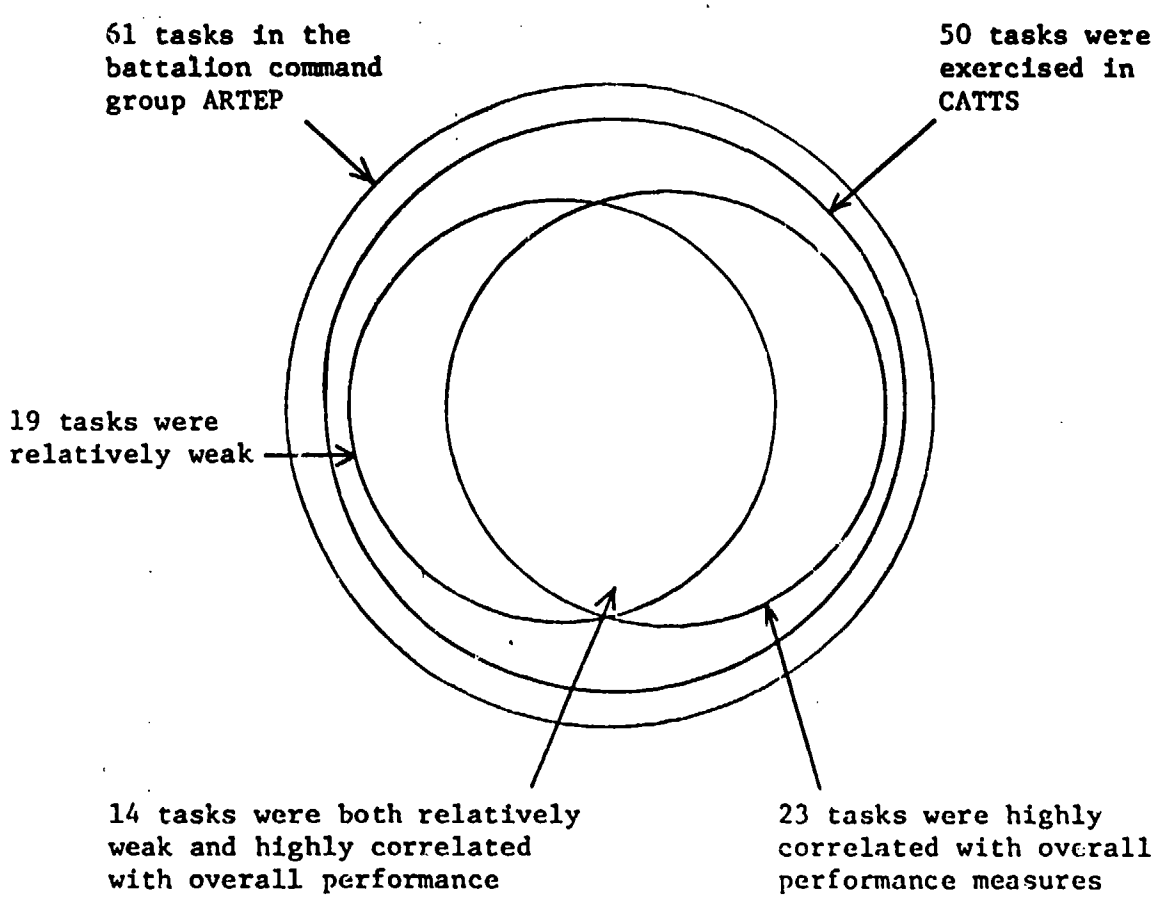

Figure 2. Classification of ARTEP tasks

LESSON 4 - Tasks that were both important and deficient were classified as critical training objectives. A second investigation of 23 battalion command groups at CATTS exercises (Kaplan & Barber, 1979) yielded results similar to those described above. Together the two investigations identified a total of 20 ARTEP tasks that were significantly correlated with overall performance and that also received relatively low performance ratings. These tasks were identified as critical training objectives for battalion command groups (see Table 1).

Table 1

Tasks Identified as Critical Battalion Command Group Training Objectives

Task		Barber & Kaplan, 1979	Kaplan & Barber, 1979
Task 1.	Develop plan based on mission		
1-B.	Identify critical combat information and intelligence	X	X
1-I.	Plan fires	X	X
Task 2.	Initiate intelligence preparation of the battlefield		
2-A.	Identify critical combat information and intelligence	X	X
2-B.	Gather critical combat information and intelligence	X	X
2-C.	Analyze opposing force	X	
2-D.	Disseminate critical combat information and intelligence		X
Task 3.	Prepare and organize the battlefield		
3-G.	Communicate/coordinate plans and orders	X	X
Task 5.	See the battlefield during the battle		
5-B.	Gather critical combat information and intelligence	X	
5-C.	Analyze opposing force	X	
5-D.	Disseminate critical combat information and intelligence	X	
Task 6.	Control and coordinate combat operations		
6-B.	Coordinate/communicate changes		X
Task 7.	Employ fires and other combat support assets		
7-A.	Modify fire support plan		X
Task 8.	Concentrate/shift combat power		
8-A.	Determine critical place and time	X	X
8-B.	Concentrate/shift combat power in the attack	X	
8-C.	Concentrate/shift combat power in the defense or retrograde	X	X
Task 9.	Manage combat service support assets		
9-A.	Arm and fuel the systems		X
9-D.	Integrate CSS into scheme of maneuver		X
Task 10.	Secure and protect the TF		
10-A.	Defeat or suppress opposing force's electromagnetic intelligence effort	X	X
Task 11.	Troop lead during battle		
11-A.	Supervise compliance with TF order		X
Task 12.	React to situations requiring special actions		
12-A.	React to opposing force electronic warfare	X	X

LESSON 5 - The tasks identified as training objectives varied with the mission. Some tasks were more difficult to perform in one mission than in another. Kaplan and Barber (1979) observed that more tasks received low performance ratings during a covering force operation than during an attack or a defense. Consequently, more tasks were identified as critical for training in the covering-force operation than in the other missions. All but one (6-B) of the tasks in Table 1 were critical in the covering force operation, five (2-B, 2-D, 3-G, 6-B, 10-A) were critical in a mechanized attack, one (2-B) in a nonmechanized infantry attack, one (9-A) in the defense, and one (2-B) in the nonmechanized infantry attack mission.

LESSON 6 - Each command group had its own training objectives. In a later investigation members of 12 battalion command groups selected their own training objectives from a list of ARTEP tasks (ARTEP 71-2, 1981) before participating in ARTBASS exercises (Kaplan, 1984). The number of objectives chosen reflected the participant's level of training. An experienced commander, whose battalion had just completed its ARTEP, chose only 1 of the 20 objectives available to him, although he added 8 of his own to the list. Other commanders chose all 20 objectives. A new S4, who chose all six objectives available to him, commented: "I have been in the unit for 2 weeks. Therefore, all areas require work and familiarization on my part."

Some objectives were chosen by almost everyone. Over 90% of the battalion commanders wanted training to Conduct commander and staff planning procedures and to Control and coordinate Bn/TF operations. A similar percentage of S2s selected Obtain information and intelligence. Most S3s chose Prepare plan/order, S4s chose Plan and coordinate logistical support, and FSOs wanted to Develop fire support plans. There was less unanimity among the S1s: the most popular objectives, Process replacements and Prepare and submit personnel daily summary (PDS), were chosen by only 64% of the S1s.

The training objectives selected for each position are listed in order of decreasing frequency in Appendix A. It is interesting to note that many of the most frequently chosen tasks were performed during the planning phase before the simulated battle began, i.e., they could be trained without the simulator.

Recommendations. The objectives of a training system should be determined empirically, i.e., by observing and interviewing the participants at training exercises. A battle simulation does not necessarily train, or need to train, all the tasks that a command group performs in combat. A training system's objective may be defined as the subset of tasks that are both strongly related to overall effectiveness and commonly deficient. Training objectives, so defined, vary with the unit's mission. They also depend on the command group members' experience and goals. The system's and the command group's common objectives should determine the content of the training exercise and of the feedback that is given to the members.

PERFORMANCE MEASURES

Four types of performance measures were used in the Field Unit's research on command group training: (1) ratings of ARTEP tasks, (2) measures of information flow, (3) responses to probes, and (4) simulation outcomes. The

lessons learned about rating ARTEP tasks include what rating scale to use, how reliable performance ratings are, and how well ratings discriminate the performance of different tasks. In addition, several lessons were learned about communication in command groups.

LESSON 7 - Performance rating scales must be suitably labeled and have an appropriate number of steps. The ARTEP itself recognizes only two levels of performance: satisfactory and unsatisfactory. Because the CATTS controllers were reluctant to characterize a command group's performance as unsatisfactory, Barber & Kaplan (1979) provided them with a three-point scale, which was defined as follows:

1 - Major departure from ARTEP standard, unsatisfactory.

2 - Minor deviation from ARTEP standard.

3 - Satisfies ARTEP standard.

After gaining experience with the three-point scale, the controllers asked for a scale that would let them make finer distinctions. Therefore the following five-point scale was introduced to increase the resolution of their task performance ratings (Kaplan & Barber, 1979):

1 - Completely overlooked, forgotten.

2 - Major deficiencies.

3 - Minor deficiencies.

4 - Satisfactory.

5 - Excellent.

Adding steps to a scale beyond the rater's ability to make distinctions does not increase the resolution of the ratings. In one investigation a magnitude estimation procedure was used. This procedure defined satisfactory performance as "100." Performance twice as good was rated 200; half as good was rated 50. The magnitude estimation procedure (Thomas, Barber, & Kaplan, 1984) and a nine-point scale (Thomas, Kaplan, & Barber 1984) gave as good but not better resolution than the five-point scale. The usefulness of a performance-rating procedure is limited by its reliability (see Lesson 9).

LESSON 8 - Raters did not discriminate well among different ARTEP tasks. That is to say, when command group performance was rated high on one ARTEP task, it was usually rated high on most other tasks as well. Factor analysis of ratings from controllers, players (the command group members), and player-controllers (company commanders and fire support team members) indicated that just a few types of performance were distinguished (Thomas, Barber, & Kaplan, 1984). Only one factor was derived from the controllers' ratings, which suggests that they did not discriminate among the tasks. Analysis of the players' ratings yielded a three-factor solution. Factor I was equivalent to Gather and analyze required information. Factor II combined Develop a plan based on mission and modify it as required by events with Communicate/ coordinate. Factor III corresponded to Implement plan and Supervise combat

operations. The player-controllers' ratings loaded on two factors: Factor I included Implement plan and Supervise combat operations; Factor II included Gather and analyze required information, Communicate/coordinate, and two-thirds of the tasks grouped under Develop a plan based on mission and modify it as required by events.

On the basis of the above results, the ARTEP rating form, which had once been expanded to 85 items (Barber & Kaplan, 1979), was reduced to the following five tasks in subsequent research (Thomas, Kaplan, & Barber, 1984):

1. Gather and analyze required information. Includes: (a) analyze mission, (b) determine what information is available and what additional information is required, (c) determine what information sources are available, and (d) gather all available information and request additional information as needed.

2. Develop a plan based on mission and modify it as required by events. Includes: (a) determine friendly capabilities and limitations, request additional assets if needed, (b) estimate enemy capabilities and likely courses of action, (c) identify key terrain, (d) select battle position/routes to objectives, (e) identify critical place, (f) develop and compare courses of action, (g) individual staff planning for communications, intelligence, operations, admin/log, fires, and (h) coordinate with other staff members.

3. Communicate/coordinate. Includes: (a) issue a warning order, (b) disseminate plans and orders, and (c) disseminate combat information and intelligence to higher and lower.

4. Implement plan. Includes: (a) concentrate/shift combat power and (b) reinforce terrain.

5. Supervise combat operations. Includes: (a) compare battlefield events with current order and concept of operations, (b) determine that a new course of action is necessary, and (c) determine that a change in implementation is necessary.

LESSON 9 - Task performance ratings were not very reliable. Raters often disagreed about how well a task was performed. The coefficient of reliability, which can vary from -1 to +1, averaged .22 for a single rater using the above five-point scale. One response to this problem was to have several observers rate the same tasks. Then the reliability of the ratings could be calculated. Moreover, the mean of several ratings is more reliable than a single rating. In the present instance, the coefficient of reliability increased from .22 for ratings from one observer to .55 for the mean ratings from five observers. Another response to the problem of low rater reliability was to develop more objective measures of performance: the information-flow, probe, and simulation-outcome measures described below.

LESSON 10 - Much information was lost in the process of communication. The first indication that communication was a problem came from ratings of ARTEP tasks. Several of the tasks in Table 1, which were commonly deficient and strongly related to overall performance, involved communication: especially Gather critical combat information and intelligence, Disseminate critical combat information and intelligence, Communicate/coordinate plans and

orders, and coordinate/communicate changes. Later a method was developed to trace the flow of information through battalion command groups (Kaplan, 1980). It used a multiple-choice questionnaire to measure the reception of information objectively. An example of an information-flow questionnaire is given in Appendix B. Data from 13 groups showed that the members received 81% of the information presented to them by brigade, but only 48% of the information that they needed to receive from other members of their own command group.

LESSON 11 - There were large individual differences in communication performance. Some people were much better communicators than others. Some were better transmitters; others were better receivers. Transmission and reception scores obtained at CATTS exercises with the information-flow methodology ranged from near zero to 100%. Battalion commanders were generally effective communicators, but their scores, too, varied over a wide range. In a sample of 32 command groups, the commanders' transmission scores varied from 42 to 92%, and their reception scores from 35 to 93%, as shown in Figure 3 (Koontz & Kaplan, 1983).

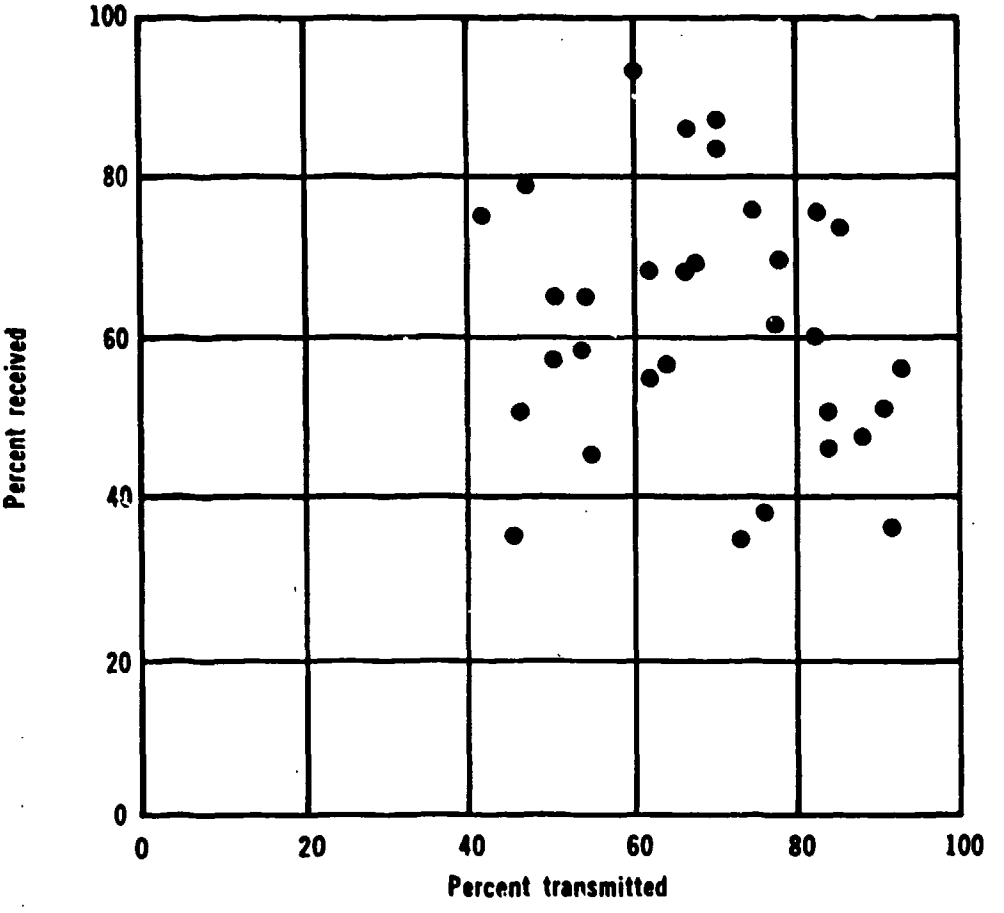

Figure 3. Distribution of communication scores from 32 battalion command groups. The percent of required information received by the commander from his staff is plotted against the percent of required information transmitted by the commander and his S3

LESSON 12 - Effective communication was associated with certain observable behaviors. The commanders' communication patterns were related to their leadership styles. Authoritarian or autocratic commanders had low transmission and reception scores: They did not seek information from their staffs, nor did they explain their orders to them. Permissive commanders, who let their staffs do most of the work, also had low communication scores. Commanders who supervised their staffs closely had higher transmission scores. Commanders who managed by exception had higher reception scores: They listened to their staffs attentively, but gave orders only to prevent errors. Commanders who used a more consultative or participative style, i.e., who interacted with their staffs during the decision-making process, had high transmission and reception scores.

Figure 4 illustrates the relationship between communication and leadership style. The horizontal axis indicates leader behaviors associated with low to high transmission, while the vertical axis identifies the leader behaviors associated with reception. The straight and curved arrows on the graph represent the loci of communication (transmission and reception) scores on a continuum of leadership styles between autocratic, participative, and permissive leadership.

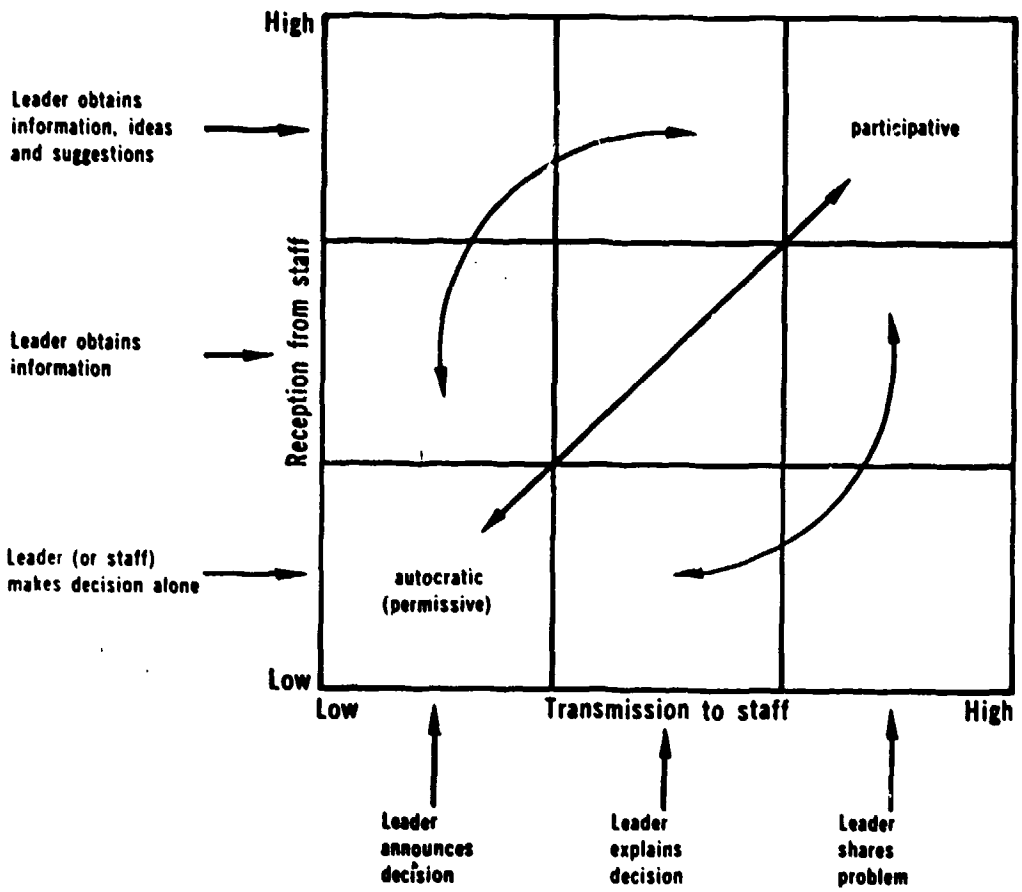

Figure 4. The relationship between communication and leadership style

Other behaviors that were related to communication performance were active listening, asking questions, and taking notes, all of which were associated with high reception scores. Careful preparation of briefings and the use of structured briefing formats contributed to high transmission scores. Calling the command group together to receive the commander's guidance, to present staff estimates, and to receive the commander's concept facilitated both transmission and reception.

Providing group members with feedback about their information-flow scores enabled them to improve their communication performance (Thomas, Kaplan, & Barber, 1984). The effects of feedback are discussed under Lessons 18-20, below.

LESSON 13 - Command group performance could be assessed by the members' responses to critical events. Thomas, Kaplan, & Barber (1984) designed "probes" to elicit coordination, communication, and information-processing behaviors within the command group. They were inserted at appropriate times in the exercise by controllers, who evaluated the timeliness, completeness, and accuracy of the responses. Figure 5 is an example of a probe inserted by the brigade S3 controller to measure the performance of the battalion S3. Probes were developed for the S1, S2, S4, and FSO, as well as for the S3. Some probes were based on requests for information by the brigade controllers; other probes came from subordinate units. Thus, probes for the S1 included a report of the loss of a company commander and of an incomplete strength report. The S2 received a report of a suspected chemical attack. The S4 received a repair order from a contact team and a report of a defective fuse, and the FSO received a report of firing on a friendly unit. Examples of other probes are given in Appendix C.

LESSON 14 - Command group performance could be measured by simulated battlefield outcomes. Thomas, Barber, & Kaplan (1984) used various ways of combining friendly and OPFOR strength and losses to indicate how successful the friendly forces were in the simulated battle. Four such measures are defined in Table 2. The Relative Exchange Ratio (RER) and Surviving Maneuver Force Ratio Differential (SMFRD) are variations of measures used in CATTS exercises. RER is simply the ratio of the proportion of OPFOR losses to the proportion of friendly losses. SMFRD is calculated by subtracting the proportion of OPFOR surviving battle from the proportion of friendly forces surviving. Both measures are, therefore, rather straightforward comparisons of losses or surviving strengths of opposing forces.

The Command and Control Index of Lethality Levels (C^2ILL) is based on the assumption that it is preferable to have a high percentage of forces surviving, while attriting a relatively high proportion of enemy forces. Hence, C^2ILL is computed by adding the two components together. The proportion of friendly forces surviving is divided in half because it was observed that in covering force missions, controller ratings of performance were more responsive to the amount of enemy forces attrited than to the amount of friendly forces surviving. The weighting factor places a higher emphasis on OPFOR losses.

The Change in Combat Ratio (ΔCR) is based on the assumption that it is preferable to end a battle with a higher combat ratio than existed prior to

Probe

Controller: Bde S3
Event: Request SITREPS.

Insertion Time
Desired: 1 1/2 hours into battle
Actual:

Expected Response

Bn S3 should examine records and provide Bde with situation report.

Actual Response

From whom: Bn S3

To whom: Bde S3

Timeliness: Immediate

Completeness:
1. Front line trace.
2. Friendly losses.
3. Probability of completing mission.

Accuracy:
Compare with computer results 15 min prior.

Figure 5. Example of a probe inserted by the brigade S3 controller to measure the performance of the battalion S3

Table 2

Definitions of Simulation Outcome Measures

Measure	Definition
RER =	$\frac{\text{OPFOR Losses/OPFOR Initial Strengths}}{\text{Friendly Losses/Friendly Initial Strengths}}$
SMFRD =	$\frac{\text{Friendly Remaining Strength}}{\text{Friendly Initial Strength}} - \frac{\text{OPFOR Remaining Strength}}{\text{OPFOR Initial Strength}}$
C^2ILL =	$\frac{1}{2}\left(\frac{\text{Friendly Remaining Strength}}{\text{Friendly Initial Strength}}\right) + \frac{\text{OPFOR Remaining Strength}}{\text{OPFOR Initial Strength}}$
CR =	$\frac{\frac{\text{OPFOR Initial Strength}}{\text{Friendly Initial Strength}} - \frac{\text{OPFOR Remaining Strength}}{\text{Friendly Remaining Strength}}}{\frac{\text{OPFOR Initial Strength}}{\text{Friendly Initial Strength}}}$

battle. The measure, therefore, computes the change in combat ratio relative to initial combat ratio.

In all the above measures, higher values indicate greater success for the friendly forces. Initial strength and losses were based on equipment and not personnel. All types of combat equipment were considered in the calculations, where tanks, APCs, TOWs, etc., were combined. Combination was achieved by adding the products of each equipment type and its corresponding combat effectiveness weight. The CATTS battle calculus included combat effectiveness weights for each piece of equipment based on its ability to destroy other types of equipment, e.g., an M60A1 tank had a weight of 73, an M113 APC a weight of 19, and a T62 a weight of 80. All four outcome measures were significantly correlated with controller ratings of overall command group effectiveness in CATTS exercises, provided that system and scenario characteristics (such as combat ratio, mission, and weather) were held constant.

Recommendations. A variety of measures should be used to assess different aspects of command group performance. Performance ratings are easy to obtain from exercise controllers and from the players themselves, once suitable rating scales have been developed. But their usefulness is limited by the rater's ability to discriminate among different levels of performance and between different tasks, as well as by individual differences among raters. More objective measures have been developed to overcome these limitations, including measures of information flow, responses to critical events (probes), and simulation outcome measures. These measures are useful for providing players with feedback to help them improve their performance and for providing

the trainers with feedback to help improve the training system. Further research should be done to develop objective measures of planning and decisionmaking behavior, to develop automated measures of performance, and to make use of advances in audio- and video-recording technology.

TRAINING EFFECTIVENESS

Battle simulations have both virtues and deficiencies. Research with CAMMS and ARTBASS identified a number of specific strengths and weaknesses, which are described in Lessons 15-17.

LESSON 15 - Command group members perceived automated battle simulations as more realistic and more instructive than conventional manual command post exercises (CPXs). In one investigation, questionnaires were administered to 50 battalion command groups after they participated in CAMMS exercises (Kaplan & Barber, 1979). The questionnaires asked the players to rate CAMMS and a manual CPX on several measures of training effectiveness. CAMMS was judged significantly and consistently more realistic than a CPX. The greatest advantages of CAMMS were exposure to the capabilities of enemy weapons systems, facing a thinking enemy, and making decisions under real-time constraints. The tasks that CAMMS exercised best were Develop plan based on mission, Prepare and organize the battlefield, Control and coordinate combat operations, Employ fires and other combat support assets, and Concentrate/shift combat power.

Similar results were obtained for ARTBASS (Kaplan, 1984), when members of 22 battalion command groups indicated how much they learned about their training objectives. The highest rated tasks were Prepare and issue orders, Prepare plan/order, Monitor operations, Control and coordinate Bn/TF operations, Plan fire support, and Control fire support. Table 3 contains a more complete list of the tasks that ARTBASS trained best, grouped by position. These tasks were selected as training objectives by a majority of the players in the specified position and received high ratings (> 3.5 on a five-point scale) on amount learned. ARTBASS was an effective command and control trainer for the battalion commander, S2, S3, and FSO. It trained about half the S4's tasks very well, but none of the objectives selected by a majority of the S1's.

LESSON 16 - Battle simulations trained some command group members better than others. Table 4 compares the results obtained with two different measures of training effectiveness. The command group members in CAMMS rated the similarity of the tasks they performed in the exercise to their actual job requirements. The players in ARTBASS rated how much they learned about command group processes, e.g., acquisition of information, communication, decision making, and execution. Both aspects of training effectiveness were rated on five-point scales with five at the high end of the scale. In spite of the differences in method and in the simulations, the average ratings for each position were similar in both investigations. In both CAMMS and ARTBASS the S3, battalion commander, and S2 received the most training, followed by the FSO and S4, while the S1 was exercised least.

Table 3

Objectives that ARTBASS Trained Best (Mean Rating on a Five-Point Scale)

Position	Objective	Rating
Battalion Commander		
	Plan fire support	4.3
	Control and coordinate Bn/TF operations	4.2
	Control fire support	4.0
	Formulate tentative plan	3.9
	Plan direct fires	3.8
	Conduct preliminary analysis	3.7
	Issue OPORD	3.7
	Conduct commander and staff planning procedures	3.6
	Prepare plan/order	3.6
	Plan maneuver control measures	3.6
	Evaluate mission	3.6
S2	Coordinate with the BN/TF HQs	4.0
	Obtain information and intelligence	3.8
	Prepare plan/order	3.8
	Prepare intelligence estimates	3.7
	Prepare analysis of area of operation	3.7
	Identify intelligence requirements	3.7
S3	Prepare and issue orders	4.5
	Prepare plan/order	4.4
	Control and coordinate Bn/TF operations	4.3
	Monitor operations	4.3
	Develop task organization/concept of operation	4.2
	Coordinate engineer support	3.9
	Prepare operations estimate	3.9
	Plan maneuver control measures	3.9
	Complete mission analysis	3.8
	Plan fire support	3.8
	Formulate tentative plans	3.8
	Conduct preliminary analysis	3.8
	Develop fire support plans	3.8
	Control unit movement and fires using graphic control measures	3.8
S4	Plan and coordinate logistical support	3.8
	Prepare logistical estimates	3.7
FSO	Control fire support	4.3
	Develop fire support plans	4.1
	Plan fire support	3.7

Table 4

Simulation Training by Position (Mean Rating on a Five-Point Scale)

Position	CAMMS (Similarity)	ARTBASS (Amount Learned)
S3	4.3	4.3
Battalion Commander	4.0	3.8
S2	4.0	3.8
FSO	3.6	3.7
S4	3.6	3.3
S1	3.3	2.8

LESSON 17 - Training simulations had certain deficiencies. The principal weaknesses of CAMMS (Kaplan & Barber, 1979) were that it did not produce much stress and did not exercise the players in security procedures, such as electromagnetic and communications security. Nor did CAMMS require the players to react to special situations, such as enemy jamming or chemical, biological, or nuclear warfare. The conventional CPX also received low ratings in these areas.

In field tests of the pre-production model of ARTBASS (Kaplan, 1984) the players recommended a number of improvements in the system. The following recommendations were among the most frequent:

1. Provide a separate facility where the battalion commander or the commander and S3 can see the battle on a visual display.

2. Provide more feedback about command group performance in the TOC.

3. Increase participation by brigade staff or brigade level controllers.

4. Add NBC and EW.

5. Improve the realism of simulated operations. Program air-to-air engagements, helicopters, thermal sites.

6. Increase activity in personnel administration. Add company XOs, 1SGs to player staff. Incorporate medical play.

7. Improve simulation of intelligence play. Increase intelligence buildup.

8. Increase activity in logistics. Add more detail. Require resupply.

9. Improve simulation of fire support. Although the FSOs reported that they learned a lot from the exercise, they recommended a variety of improvements.

Table 5 lists the command group training objectives that ARTBASS trained least successfully, i.e., the tasks selected as training objectives by a majority of the players at each position which were rated below 3.0 (some) on a five-point scale of amount learned. Implementing the players' recommendations would correct many of the weaknesses in ARTBASS.

Table 5

Objectives that ARTBASS Trained Least (Mean Rating on a Five-Point Scale)

Position	Objective	Rating
S1	Prepare and submit personnel daily summary (PDS)	2.4
	Prepare estimates	2.4
	Process casualty feed reports	2.0
	Process replacements	1.4
S4	Supervise logistical operations	2.9
	Request supplies	2.3
FSO	Coordinate joint air attack teams (JAAT) operations	2.7

Recommendations. Battle simulations generally train commanders, operations, fire support, and intelligence better than logistics and administration. Besides making simulations more complete, it would also be desirable to develop modular systems that train individual staff sections. In addition to providing each staff element with optimally focused training, such part-staff trainers could be used providing supplemental training to less experienced staff members. At corps and division levels part-staff trainers would be an economical alternative to large-scale exercises for the entire staff.

FEEDBACK

The term feedback refers here to information about their performance that the command group members receive during a training exercise. Lessons 18-20 discuss the requirement for feedback in battle simulations.

LESSON 18 - Training simulations provided the players with incomplete feedback about their performance. The command group members were generally unable to trace the remote or delayed consequences of their actions. This limitation applied particularly to the training objectives that were exercised during the planning phase before the simulated battle began. Nor did the players realize when they failed to transmit or receive essential items of information. They could not see their own performance from the perspective of the brigade, company, or threat controllers. Unlike the controllers who had observed many previous groups, the players could not compare their performance with that of other groups. Thus, merely participating in the simulation did not by itself diagnose deficiencies or suggest improvements.

LESSON 19 - Without added feedback, simulation training produced limited improvement in command group performance. Five battalion command groups participated in a 4-day CATTS exercise with only intrinsic feedback, i.e., only the knowledge of results available through their own observations (Thomas, Barber, & Kaplan, 1984). They received a complete after action review (AAR), but only at the end of the last exercise day. The command group members and the brigade controllers reported a significant improvement in ARTEP task performance from the first to the fourth day of the exercise. However, there were no significant improvements in the player-controllers' (company commanders') ratings of group performance in simulation outcome measures or in intra- and inter-group communication, as measured by the information-flow methodology.

LESSON 20 - Providing additional feedback during an exercise increased the improvement in performance produced by simulation training. Five battalion command groups were given detailed diagnostic feedback about their performance on the second day of a 4-day CATTS exercise (Thomas, Kaplan, & Barber, 1984). On the first exercise day, performance was measured by ARTEP task ratings, information-flow scores, probes, and simulation battlefield outcomes. The command group members received feedback about all these measures on the morning of the second day. They continued training on the second and third days and were evaluated again on the fourth day. Every performance measure increased significantly from the first to the fourth exercise day as shown in Table 6, which compares the improvement with diagnostic feedback to that obtained in the previous study without added feedback during the exercise.

Table 6

Improvement in Command Group Performance With and Without Feedback (Statistical Significance)

Performance Measure	With Feedback	Without Feedback
ARTEP Ratings		
Players	$p < .05$	$p < .01$
Controllers	$p < .0001$	$p < .001$
Player-controllers	$p < .01$	Not significant
Information Flow		
Brigade to Battalion	$p < .05$	Not significant
Within the Bn Cmd Grp	$p < .01$	Not significant
Battalion to CO Cdrs	$p < .01$	Not significant
Probes	$p < .05$	Not used
Simulated Battle Outcomes	$p < .05$	Not significant

Recommendations. Merely participating in an exercise does not necessarily improve command group performance. To maximize the training benefit of an exercise, the group members should be given extensive feedback about their performance. In particular, they should be given feedback relevant to their training objectives. The optimum content, duration, and format of feedback remain to be determined, but it should incorporate the playback capability of automated simulations, audio-video inputs, and objective performance measures, as they continue to be developed.

SUMMARY

The process of training system development begins with the determination of objectives, which establish a basis for designing the system and for developing performance measures. The measurement data obtained during training exercises are used to provide the system designers and operators with feedback about the effectiveness of their system. Lessons learned in research on command group training were grouped into four categories derived from this model: (1) training objectives, (2) performance measures, (3) training effectiveness, and (4) feedback.

The objectives of a command group training system were defined as those ARTEP tasks exercised by the system that were both highly correlated with overall performance ratings and frequently deficient. Training objectives were found to be mission-dependent and to vary from one command group to another.

Performance measures, derived from the training objectives, included ratings of task performance by the exercise controllers. The rating scales had to be carefully defined, but still did not discriminate well among different tasks and were not very reliable. To remedy these deficiencies, more objective measures of information flow, responses to critical incidents (probes), and simulation outcome measures were developed.

Automated battle simulations were generally perceived as realistic by the command groups that they trained, although they trained operations and intelligence functions better than logistics and administration. Merely participating in an exercise did not necessarily improve a command group's performance. However, providing additional feedback about task performance ratings, information flow, critical incidents, and simulation outcomes helped the group members to increase all those measures of their performance.

The methods developed in this research can be used by system developers and operators to refine training objectives, to assess command group performance and training system effectiveness, and to provide feedback about performance that enhances training effectiveness. The results obtained with these methods suggest several promising lines of future research. In the area of performance measurement, further research should be done to develop measures of planning and decision-making behavior, to automate performance measurement, and to utilize advances in audio- and video-recording technology. Training effectiveness can be increased by developing modular simulations to train individual staff sections. Such part-staff trainers would be especially economical at corps and division level. Finally, training effectiveness can

be increased by further research on the type and amount of feedback provided to players during the exercise.

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APPENDIX A

TRAINING OBJECTIVES SELECTED IN ARTBASS EXERCISES

Objectives	Percent Selected
Battalion Commanders	
Conduct commander and staff planning procedures	92
Control and coordinate Bn/TF operations	92
Prepare plan/order	83
Issue OPORD	83
Plan fire support	75
Issue planning guidance	67
Plan maneuver control measures	67
Evaluate mission	58
Formulate tentative plan	58
Issue warning order	58
Control fire support	58
Conduct preliminary analysis	50
Prepare estimates	50
Plan direct fires	50
Control unit movement and fires using graphic control measures	50
Issue FRAGO	50
Control direct fires	50
Complete mission analysis	42
Maintain orientation	33
React to indirect fires	33
S1	
Process replacements	64
Prepare and submit personnel daily summary (PDS)	64
Prepare estimates	55
Process casualty feed reports	55
Forecast losses (CMBT)	45
Coordinate medical support	45
Prepare plan/order	27
S2	
Obtain information and intelligence	92
Prepare intelligence estimates	83
Prepare analysis of area of operation	75
Identify intelligence requirements	75
Prepare plan/order	67
Coordinate within Bn/TF HQs	50
React to direct fire	42

Objectives	Percent Selected
S3	
Prepare plan/order	92
Complete mission analysis	83
Control and coordinate Bn/TF operations	83
Develop task organization/concept of operation	75
Plan fire support	75
Coordinate engineer support	75
Prepare and issue orders	75
Formulate tentative plan	67
Evaluate mission	58
Conduct preliminary analysis	58
Develop fire support plans	58
Monitor operations	58
Control unit movement and fires using graphic control measures	58
Issue FRAGO	58
Prepare operations estimate	50
Plan maneuver control measures	50
Issue warning order	42
Control fire support	42
Plan direct fires	33
Coordinate joint air attack team (JAAT) operations	33
Coordinate air defense support	17
Maintain orientation	17
Control direct fires	17
React to indirect fires	17
S4	
Plan and coordinate logistical support	92
Prepare plan/order	75
Prepare logistical estimates	67
Supervise logistical operations	67
Request supplies	58
Receive supplies	33
FSO	
Develop fire support plans	92
Plan fire support	67
Control fire support	67
Coordinate joint air attack team (JAAT) operations	58
React to indirect fire	42

APPENDIX B

INFORMATION FLOW QUESTIONNAIRE

Position _____ Date _____

Answer all questions. Circle the letter before the answer that you believe is correct. Do not guess. If you do not know the answer, answer "unknown." Some questions may cover information to which you did not have access.

1. Your TF has been instructed to go to BP _____ after passage of lines.

   a. A
   b. D
   c. E
   d. unknown

2. FM radio listening silence will be imposed until _____.

   a. lifted by TF headquarters
   b. reaching the SP
   c. reaching the RP
   d. unknown

3. The minefields and obstacles emplaced in your sector by the 201st ACR _____ by the engineers.

   a. are planned
   b. are in the process of being verified
   c. have been verified
   d. unknown

4. Which one of the following statements is correct?

   a. U.S. forces may initiate fire with the TF commander's approval.
   b. The covering force may return fire if fired upon.
   c. U.S. forces may fire at any movement on the OPFOR side.
   d. unknown

5. The ADA weapons control status is _____.

   a. free
   b. tight
   c. hold
   d. unknown

6. Attack helicopters available to your TF for planning purpose are _____.

   a. one platoon
   b. two platoons
   c. one troop
   d. unknown

7. _____ aircraft are available for close air support.

a. F-111
b. A-10
c. F-15
d. unknown

8. Close air support response time for strip alert is _____ minutes.

a. 10 to 20
b. 30 to 40
c. 50 to 60
d. unknown

9. Medical evacuation will be conducted to the _____.

a. 52nd Mech Div TNS
b. 1-23 Cav Field TNS
c. TF IKE TNS
d. unknown

10. Personnel replacements are available within _____.

a. 12 hours
b. one day
c. two days
d. unknown

11. Wounded POWs are evacuated through medical channels _____.

a. with US wounded
b. after US wounded
c. as directed
d. unknown

12. Local private dwellings and business are _____.

a. off-limits to all soldiers
b. off-limits except with owner's permission
c. available for TF use
d. unknown

13. OPFOR will have _____ during the first 12 hours of hostilities.

a. air superiority
b. air parity
c. no air support
d. unknown

14. OPFOR aerial reconnaissance has _____ significantly in the past 48 hours.

a. increased
b. decreased

c. not changed
d. unknown

15. The covering force can expect to be opposed by the _____.

a. 49th Motorized Rifle Division
b. 17th Motorized Rifle Division
c. 23rd Motorized Rifle Division
d. unknown

16. OPFOR has the capability to employ nuclear as well as chemical and biological weapons. Current indications are that _____.

a. chemical and nuclear weapons probably will be used
b. nuclear weapons units have been deployed well forward
c. OPFOR has given no indication they will use NBC weapons
d. unknown

17. OPFOR units are estimated to be at _____ strength.

a. 97%
b. 100%
c. 103%
d. unknown

18. There is _____ guerilla activity in the brigade area.

a. increased
b. little
c. no noticeable
d. unknown

19. Attachments should come _____.

a. with their CSS
b. without CSS
c. with CSS as needed
d. unknown

20. Requests for replacements of major end items will require at least _____ hours to fill after hostilities begin.

a. 12
b. 48
c. 24
d. unknown

21. The CSR for TOWs is _____ rounds.

a. 3
b. 6
c. 9
d. unknown

22. Aerial resupply is _____.

a. available from corps
b. limited
c. available from division
d. unknown

23. Convoy movements may be conducted only _____.

a. during darkness
b. from dusk to dawn
c. from 2400 to 0400
d. unknown

24. There are shortages of _____ rounds.

a. HE
b. smoke
c. DPICM
d. unknown

25. No more than _____ of CSR will be expended to support covering force operations.

a. 40%
b. 50%
c. 60%
d. unknown

26. Requests for quick smoke must be approved by the _____.

a. FIST chief
b. company commander
c. TF commander
d. unknown

27. Aerial observation is _____.

a. not available due to shortages of aircraft
b. available 150800
c. available for high priority missions
d. unknown

28. Artillery should be used on targets of _____ or more vehicles.

a. 3
b. 5
c. 7
d. unknown

APPENDIX C

EXAMPLES OF PROBES

Probe

Controller: Co XO
Event: Company inputs incomplete strength reports.

Insertion Time
Desired: After losses have occurred
Actual:

Expected Response

Bn S1 should recognize incompleteness and request additional information.

Actual Response

From whom: Bn S1

To whom: Co XO, Plt Ldrs, or Plt Sgts

Timeliness: Immediate

Completeness:

Request all incomplete lines.

Accuracy:

Request appropriate items only.

Probe

Controller: Bde S2
Event: Request from Bde S2 for estimate of OPFOR unit TF is facing

Insertion Time
Desired: 1 1/2 hours after initial contact
Actual:

Expected Response

Bn S2 determines unit type through intelligence gathered by S2 sources.

Actual Response

From whom: Bn S2

To whom: Bde S2

Timeliness: Immediate upon request

Completeness:

1. Unit size
2. Unit type
3. Main attack?

Accuracy:

Compare S2 estimates with actual OPFOR.

Probe

Controller: Bde S4
Event: Final estimates of equipment strength

Insertion Time
Desired: 15 minutes before end of exercise
Actual:

Expected Response

Bn S4 reviews records and reports to Bde.

Actual Response

From whom: Bn S4

To whom: Bde S4

Timeliness: Within 15 minutes

Completeness:

All equipment included

Accuracy:

Compare with actual losses 15 minutes prior.

Probe

Controller: FIST
Event: FIST calls for fires out of sector.

Insertion Time
Desired: During intense Arty opns
Actual:

Expected Response

Bn FSO should identify and cancel fires.

Actual Response

From whom: Bn FSO

To whom: FIST or FDC

Timeliness: Immediate

Completeness:

FSO responds.

Accuracy:

Correctly cancels fires.
